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The agroecological transition of agricultural systems in the Global South

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Chapter 18

Agroecological transition of agriculture in the countries of the Global South: taking stock and perspectives

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Agriculture around the world is being called upon today to adapt in order to meet societal demands, environmental challenges, and climatic disruptions. Agriculture in countries of the Global South is, in particular, facing specific and often unprecedented challenges of population growth, rapid urbanization, globalized markets and macro-economic structures still dominated by the primary and informal sectors. In recent decades, agriculture in these nations has evolved in contexts that have complicated the task of negotiating solutions with the actors concerned: the withdrawal of States from agricultural and rural sectors; the emergence of new actors with contradictory interests and strong asymmetries between, for example, producer organizations and globalized agro-industries; low levels of public sector intervention resulting in a lack of quality public goods, especially in the areas of infrastructure and services.

In a context of intense transformations, the actors of the agricultural world must therefore innovate to adapt, ensure resilience and inclusivity, reconcile productivity and environmental sustainability and, at least in sub-Saharan Africa, join other development actors in creating jobs in massive numbers for an increasing number of young people entering the labour market.

Agroecology offers a new paradigm of sustainable agricultural and food systems, which we believe are better able to address societal expectations, global environmental, nutritional and health emergencies, the political orientations of different countries, international initiatives, in particular those of FAO (2018) and Sustainable Development Goals (Caron *et al.*, 2018).

More than 20 years of research, experimentation and support for projects in agroecology, carried out in Africa, Madagascar and the Indian Ocean, Southeast Asia, Latin America and the Caribbean, constitute a significant capital of results and knowledge that CIRAD and AFD have wanted to share through this book.

Two thematic fields stand out from these experiments and experiences:
– what are or could be effective and adapted agroecological systems, through an application of design and evaluation approaches to these systems;
– the manner in which these innovative systems could be deployed through a strong reliance on the human and social sciences.

This summary chapter provides a brief overview of the previous chapters, before proposing, on the basis of these experiences, paths to better support, extend and accelerate the crucial process that is the 'agroecological transition'.

Agroecological transition for agriculture in the Global South: what exactly do we mean?

Many alternative production systems have been proposed in the past several decades in an attempt to respond to the challenges posed by global changes for the countries of the Global South. Some of these systems (organic farming, conservation agriculture, agroforestry, ecological intensification, etc.) have some aspects in common in varying degrees: the optimization of biological and ecological regulation processes, the frugal management of resources, and the sustainable management of nutrient cycles. These systems can be considered as agroecological systems or variants thereof. They have the aim of ensuring agricultural production at the same time as environmental sustainability, and of contributing to a healthy and diversified diet.

Agricultural systems in the Global South are highly diversified. The varied climate, soil and altitude conditions form a matrix of this diversity. The type of production, the modalities of access to land and inputs, the links to markets, the capital invested, the level of intensification and the different modes of production come together in an infinite number of combinations. As a result, each rural society has its own dynamics and the choices it makes in terms of production methods or structuring of agri-chains have specific environmental, economic and social impacts. Consequently, agroecology cannot be promoted as a single model to be followed, but instead as a process of transformation, taking place each time in a specific situation and along a multitude of possible trajectories.

In its founding principles, agroecology not only is based on the management of ecological processes in order to produce environmental services, but also often involves a social and political dimension in the transformation of production methods and, more generally, of food systems in their entirety.[1] This form of agroecology, with a social and political dimension, which can be called 'strong' agroecology[2], runs counter to the conventional intensification model. In contrast, 'weak' agroecology is often dismissed by the proponents of strong agroecology as a mere 'greening' of conventional intensive farming through the adoption of a limited number of agroecological practices. To further clarify these differences, we can refer to the three pillars of the concept of sustainable agriculture for development, as defined by the High Level

1. For a review of the different definitions of the concept of agroecology, see Altieri (1983), Altieri *et al.* (2017), Gliessman (2014), Wezel *et al.* (2009), and Stassart *et al.* (2012).
2. Referring to the distinction between weak and strong sustainability introduced by Daly (1990).

Panel of Experts on Food Security and Nutrition of the UN Committee on World Food Security (HLPE, 2016):
– improve the efficiency of production resources, natural resources and the environment;
– strengthen the resilience of systems (ability to react and adapt to shocks);
– ensure equity and social responsibility.

In this context, the definition of weak agroecology mainly pertains to the first pillar, whereas strong agroecology encompasses all three.

CIRAD and AFD together advance the hypothesis that, given the scale and urgency of the challenges of global change, the majority of production methods in countries of the Global South, irrespective of their degree of intensification, will have to base themselves on the concepts of agroecology in order to become part of a process of economic, environmental and social progress.

Regardless of the type of agriculture considered, two main types of fundamentally linked levers for an agroecological transition are identified in this book's various chapters.

The first is of a technical nature and is based on a better mobilization of functional biodiversity in order to improve the performance of cropping or livestock systems, naturally regulate pests and diseases, and reduce the use of pesticides. It also takes into account the objective of maintaining or improving, including in the long term, the efficiency of use of natural resources (water, energy, soil, etc.) and of managing biogeochemical cycles in order to cut down on the use of nutrients from outside the ecosystem and to reduce the risk of water eutrophication caused by the leakage of nutrients out of the farming system.

The second lever is of a cognitive and organizational nature and relies on the importance of concerted dynamics between producers and all the other actors of agricultural development in the implementation of agroecological systems at the plot scale, the territorial scale and even the national scale. This lever pertains to how and how well actors work together (diversity of actors and power relationships, of strategies and capacities) and to support services for innovation. It takes the political dimensions (roles and forms of public action required) of the transition into account.

The agroecological transition thus appears as a set of linked technical and organizational processes through which new production models based on the principles of agroecology progressively replace the systems based on conventional intensification – or allow very low productivity farmers to intensify their production without adopting the conventional intensification model. In either case, it is important to arrive at a form of agriculture that is able to ensure global and local food security sustainably in all possible dimensions. These transformations are most often accompanied by the quest for greater autonomy for the systems, and therefore of the actors, as far as inputs and services required are concerned, which are generally controlled by large economic actors. Transition therefore inevitably requires strong political choices – inescapable sources of tension – and therefore negotiations.

For CIRAD and AFD, the agroecological transition encompasses both ecological intensification (Griffon, 2013) of low-input agriculture and reduction in the use of

inputs in conventional intensification agriculture. However, in the latter case, we think it only appropriate to reserve the term agroecological transition to profound changes in these systems, involving both a reorientation of the way of producing and a focus on the economic and social sustainability of the territories in which they are located. Table 18.1 summarizes what agroecology could contribute to different forms of agriculture in the Global South.

Table 18.1. Potential contributions of agroecological solutions to different forms of agriculture in the Global South.

Expected functions	Forms of agriculture		
	'Small' family farming with no or low levels of chemical inputs use	'Medium-size' agriculture based on principles of conventional intensification using chemical inputs	Industrial agriculture: highly intensive and mechanized
Maintaining or increasing production	++		
Improving farmer incomes and increasing farm resilience	+++	+	
Reducing negative environmental impacts	+	+++	+++
Promoting non-production services	++	++	+
Favouring decent rural employment	+++	++	+
Adapting agriculture to better cope with climate change	+++	+	+
Help mitigate climate change		++	++

The number of crosses denotes the potential of the contribution of agroecological solutions.

Food systems are also evolving in response to the challenges posed by global changes. Agroecological transition is not the most appropriate term to describe the transition of these systems since agroecology is based on the bringing together of agronomy and ecology, whose concepts are only very partially used in food processing systems. However, objectives of improvement of food systems are common and complementary to those of the transition of the production sectors: promotion of a healthy and varied diet; more efficient use of water, energy, and other natural resources; a reduction of losses and waste; and promotion of short circuits and participatory certifications. The agroecological transition of farming systems and the transition of processing and distribution systems are therefore two inseparable and essential components of the implementation of sustainable food systems.

Technical levers based on the mobilization of functional biodiversity

From the feedback of experiments reported in this book, four main types of biological and biophysical levers of the agroecological transition can be distinguished. Their main functions are summarized in Table 18.2.

Using functional biodiversity to help fight pests and diseases and favour processes of natural regulation

A common result of the studies reported in this book concerns the regulation of pests and diseases using techniques that mobilize functional biodiversity and, consequently, the avoidance or reduction of the use of pesticides. The use of this biodiversity makes it possible to reduce the dynamics of pest development through various competition and predation processes (Chapters 6 and 7) and, additionally in some case, through physical barriers such as anti-insect nets (Chapter 4). The structure of the plant and animal communities present in the agroecosystem also influences the nature and intensity of biological regulation (Chapters 2, 7 and 11).

The experiments presented also confirm an improvement in the use of natural resources, in particular light energy, nitrogen, air carbon, water and nutrients, in systems based on the principles of agroecology. This objective is attained by maximizing biomass production by using service plants, crop associations and rotations, and enhancement of soil biological functioning (Chapters 2, 5, 6, 7 and 11).

A judicious increase in functional biodiversity thus favours production as well as stability and resilience of the system in the face of hazards (drought, invasive organisms, etc.). It is also possible to improve the stability of agricultural production by increasing interspecific genetic diversity (associated crops, diversified rotations, introduction of pastures) and by associating several vegetation strata as in agroforestry (Chapter 1, 2, 6, 9 and 11). Increasing intraspecific diversity (populations or mixtures of cultivars) increases production and the system's resilience (Chapters 2 and 6). Biocontrol techniques target host-parasite interactions or vectors, and act directly on some biodiversity components (Chapter 7). The diagnosis of functional soil biodiversity helps improve its management and thus enhances its ecological services (Chapters 2, 5 and 11).

Functional biodiversity is managed at the level of the plot and at its periphery (hedges, ditches, grass strips, etc.), and also at the watershed and territorial levels (Chapter 5). While the mobilization of diversity is not in itself a universal solution, the experiments described in the book testify to the very important progress made in the mastery over multi-species systems and in the engineering of service plants (Chapters 2, 5, 6 and 7). The use of the concept of functional traits has, in particular, made it possible to characterize the potential of cover plants to render a set of services on the basis of some of their characteristics and to work out their optimal deployment in space and time (Chapter 2, 5, 6 and 11).

Managing the nutrient cycle in a sustainable manner

Agroecological practices have the goal of conserving water and nutrient resources quantitatively and qualitatively, avoiding, for example, erosion and soil compaction through permanent soil cover. They also aim to promote the infiltration of water and the recharge of aquifers, while limiting nutrient losses through runoff and leaching (Chapters 2 and 5). During the nitrogen and phosphorus cycles – the very basis of crop production –, there may be losses of elements in the environment, resulting in the waste of nutrients, organic matter and energy, as well as water and air pollution, and

greenhouse gas emissions (Chapter 13). To avoid these negative consequences and to improve production efficiency, the agroecological transition leads to the 'closure' of major cycles (i.e. to prevent the escape of nutrients from the farming system) through the combination of a series of practices: biological fixation of nitrogen, storage of carbon and nutrients in soil organic matter, recycling and use of farm fertilizers, combination of cropping and livestock systems, selection of animal breeds and plant varieties on the basis of their efficiency of capture and exploitation of resources, and crop rotations and technical itineraries favouring a temporal matching of the availability of resources and the demand by plants (Chapters 1, 3, 5, 6, 8 and 11).

Managing landscapes

The judicious arrangement of plots and their environment in space (landscape mosaics) can strengthen the control of certain pests, extend the habitat of certain regulating organisms, and promote pollination services (Chapters 5, 6 and 7). Incorporating agroecological management into the development of a landscape mosaic within a territory also helps to better preserve crucial resources (water and soil) and limit the flow of nutrients or pesticides to the natural environment. This management of the spatial organization of plots involves the use of grassed elements and hedges (Chapters 5, 7, 8 and 11).

Redefining the goals of plant and animal genetic improvement

The agroecological transition brings new challenges in terms of breeding (Chapters 2 and 9). The knowledge of ecological functioning transforms the objectives of plant and animal breeding and selection and affects the choice of new characters and ideotypes in order to take the potential interactions of plants and animals with each other and with their environment better into account.

The optimization of biological and ecological interactions requires, in particular, the contextualization of varietal solutions, i.e., a better integration of the local constraints of and expectations from farming systems, crop successions and combinations, available biodiversity, etc. This approach means broadening the range of objectives and selection criteria, the consideration in some cases of longer time scales and of spatial scales exceeding those of the plot and the farm, and the taking into account of local knowledge and local uses in selection processes. The diversity and speed of ecological, technical, economic and social changes are raising new questions about the strategy of varietal deployment specific to each species. The goal has now become to design genotype mixtures that encompass a wider range of optima, rather than aiming for an ideal all-purpose genotype. New ways of managing genetic diversity are being explored in a quest for this better adaptation, in particular through participatory selection methods (decentralized dissemination, open-access varietal formulas, identification of mechanisms underpinning plant interactions, multi-genotype selection, local 'refining' of varieties, etc.).

The changes induced by promoting diversity within systems by mobilizing and managing a greater functional biodiversity in order to provide various services within and around the cultivated area, encouraging technical and organizational breaks with

standard systems, and favouring the taking of supra-plot scales into account will all lead to the development of more complex systems. They will also imply a new and stronger involvement not only of producers, technicians and advisers but also of territorial and agri-chain actors in developing modes of agroecological production. The different chapters of this book's first part show that this requires local knowledge to be taken into consideration and a participatory approach in which the producers are accorded a central role in undertaking diagnoses, prototyping of new solutions, and the assessment and adaptation of these prototypes.

Table 18.2. Technical levers of the agroecological transition for natural regulation.

Biophysical technical levers	Expected functions					
	Mobilizing functional biodiversity			Promoting crop-livestock interactions	Organizing landscape mosaics	Redifining the goals of genetic improvement
	Service plants	Crop associations	Rotations			
Fighting pests and weeds with biotic regulations	+++	+++	+++		++	++
Improving plant nutrition and nutrient utilization efficiency	+++	++	+++	+++	+	++
Recycling resources and managing water and nutrient cycles	++	+	+++	+++	++	+
Limiting erosion	+++	++	+++		+	

The number of crosses denotes the potential of each lever on each function.

Cognitive and organizational levers

This book highlights how much the progress of the agroecological transition depends on changes both at the individual level (what the actor knows and how he acts) as well as at the collective level (how collective action is organized). Cognitive and organizational levers are therefore essential for the deployment of agroecological alternatives to conventional intensification-based production models. Changes in ways of thinking and in working practices have to take place at the different levels of organization of agricultural activity: territories, agri-chains, producer organizations, etc. These changes can be triggered in various ways, in a more or less supervised manner (Chapter 14), through the implementation of intervention mechanisms or the provision of services to support those undertaking the transition and to address their specific needs.

Over the course of this book's chapters, three types of support systems for cognitive and organizational changes have been analysed and appear complementary and essential to the agroecological transition:

– collaborative innovation mechanisms such as 'innovation platforms', which support collective action for change, and coordination between and alignment of interests of the various categories of actors involved in the deployment of agroecological alternatives (Chapter 14);

– 'territorial mechanisms' that support the reorganization of activities in territories (Chapter 16);
– novel institutional frameworks that support the development of new agri-chains – especially of those linked to organic farming – and the evolution of traditional ones, and which encourage the formulation of pro-agroecology public policies (Chapters 14, 15 and 17).

Each of these mechanisms is based on a vision of the changes to be made, on methods of supporting individual and collective learning, and on new skills specific to the agroecological transition. For example, they encompass activities aimed at:
– identifying and leveraging the diversity of strategies and capacities of producers, and encouraging their active participation in and voluntary commitment to the agroecological transition of their systems (Chapters 5, 10, 14, 15 and 16);
– promoting the capitalization and transmission of knowledge (scientific or originating from producers' practices), the use of feedback, the learning of producers and rural populations (peer-to-peer, demonstrations, tests, training) (Chapters 5 and 16);
– improving the engagement and capacity of producer support services (Chapters 14 and 16);
– encouraging the involvement of downstream and upstream operators of the agri-chains concerned (Chapter 9), e.g. for the supply of seeds, inputs, and adapted mechanized equipment;
– taking consumer needs and expectations into account in a short- and long-term prospective vision, promoting the marketing of productions based on agroecological practices, proposing standards to recognize products from systems that espouse environmental and social values (Chapter 15);
– encouraging policymakers to increase their political and institutional commitment to ensure support for local and territorial initiatives through appropriate political and legal frameworks (laws; regulations; economic, financial and fiscal instruments) (Chapters 10, 16 and 17).

These activities call for new profiles for development agents, facilitators and those providing support to these change-inducing multi-stakeholder innovation partnerships or development networks. As a result, training and education mechanisms must also evolve in parallel to be able to provide training in the new jobs related to transition (Chapters 2, 5, 6, 7, 10, 14 and 16).

Innovation platforms: ensuring local support

The authors of many of the book's chapters not only confirm the importance of local support but also highlight its difficulties and limitations (Chapters 1, 2, 10, 14, 15 and 17). At present, the most successful mechanisms pertain mainly to agricultural production at the farm scale and the regional agri-chain scale, and primarily involve farmers and their direct upstream and downstream contacts. The purpose of these support mechanisms is usually to contribute to the construction and exchange of knowledge between local actors and to the sharing of practices between them; facilitate collective action and the evolution of collaborative practices; catalyse the formation of relationships between multiple organizations; and facilitate action planning, monitoring and evaluation, and capitalization.

Some of these platforms are part of the 21 platforms in partnership for research and training co-managed by CIRAD with its partners in the various countries of the Global South.

Strong contrasts are inherent to the agroecological transition and influence the operationality of these innovation platforms:
– the long time required for learning new technical approaches based on agroecological concepts, for the construction of social and human capital and for the tangible expression of results are in stark contrast to the actors' expectations of quick results so that they can satisfy development donors (Chapter 14);
– the actors have different and even divergent interests, which make it difficult to build a shared vision of the problems and their solutions.

While innovation platforms are able to stimulate local dynamics, they often struggle to take them to their conclusion in a short period. One solution can be to extend the life of these platforms beyond the completion of the projects concerned, so that the targeted objectives can be attained (Chapter 14). The studies have additionally shown that the objectives assigned to these mechanisms need to be clarified and defined more precisely. This would make it possible to identify and deploy the type of coordination mechanism between actors that is most suited to each situation (platform, network, innovation partnership). And doing it at different scales (local, regional, national) would make it possible to address the issues relevant at each territorial level with the appropriate actors. The results also underscore the need to renew forms of support for and funding of platforms, so that they are made more flexible, focused on strengthening collaborative and cognitive processes, and not just on obtaining technical and economic results (Chapters 10 and 14). Finally, all the experiments carried out show the importance of building up the capacities of the individuals in charge of undertaking innovation: the producers themselves, of course, but also the other agents of change (technicians, agricultural advisers, trainers and even rural leaders). These (re)orientations and adaptations will make these mechanisms more effective and facilitate the agroecological transition.

Territorial mechanisms: invoking the territory and policymaking

One of the key elements of development is the best possible use of resources available in a territory through the implementation of renewed approaches (Caron *et al.*, 2017). Territorial mechanisms try to respond to this need for accompanying the agroecological transition (Chapter 16). They complement the functions provided by innovation platforms because they are focused on the territory, its specificities and its political context. Their organizational and institutional processes and frameworks (governance) pertain to political spheres and markets, and are little concerned with biotechnical processes. The territorial mechanism constitutes in itself an institutional arrangement formalized between territorial actors, and an intentional assembly of heterogeneous elements (norms, discourses, practices, instruments, tools, organizational structures, knowledge, etc.). The whole is designed to address a shared purpose in the territory: encouraging, supporting, and consolidating the agroecological transition by leveraging local knowledge and the territory's resources, by fostering collaborations

between stakeholders keen to promote agroecology, and by proposing new values, standards and rules compatible with agroecology or conducive to its adoption.

Several principles govern the construction and the mobilizing deployment of a territorial mechanism (Chapter 16):
– the effective involvement of actors as a fundamental principle, across all stages. Participatory and support tools for collective action are thus emphasized, aimed at the matching and hybridization of knowledge, negotiation, the search for synergies and points of convergence, the formalization of agreements, dispute resolution support, etc.;
– the initial diagnosis, as an essential step to take the diversity of the actors into account (production models, agri-chains, markets, etc.);
– the shared acknowledgement of this diversity and of temporalities in the change for each of the actors and their forms of organization;
– an accurate and shared knowledge of external standards (regulatory frameworks, policies and measures to support the agroecological transition) and dynamics endogenous to the territory (strategies and objectives of the various actors);
– the definition of a suitable territorial perimeter, which can range from the very local (municipality) to the regional, validated by the actors, and in which they recognize themselves and feel able to act together.

As a common good, shared and governed by a set of local actors, a territorial mechanism is sustainable if the conditions specified by Ostrom (1993) are met. Nevertheless, it is necessary to involve representatives of public action (local elected officials, for example), whose role is often crucial to initiate action, convince higher levels of governance, and influence the drafting of corresponding public policies. To ensure its appropriation by local stakeholders, as well as their participation and sustained interest, the territorial mechanism must also remain focused on the objectives assigned by these actors and on finding answers to their concerns through suitable products: new local standards, charters, certification schemes, capacities, and properly governed common goods (nurseries, supply mechanisms, transport). The management and the quality of information are crucial elements of a territorial mechanism's functioning, which must produce relevant, usable and actually used information (for example, a technical reference base on agroecology experiments in the territory). It is essential to produce summary documents that are easily understandable, for example in the form of maps. Information should not, however, replace the necessary guidance and facilitation. These actors must be supported, often trained, in acquiring new technical as well as organizational capabilities. Innovative facilitation and participation methods have shown their potential (role playing, participatory modelling, farmer-to-farmer exchange methods, etc.).

Innovative institutional mechanisms to support the marketing and development of new agri-chains

Even though the issues concerning the marketing of agroecology products appeared later than those pertaining to production systems in the timeline of research and development work on the agroecological transition, they are not any less important. The adoption of agroecological practices often leads to lower yields and additional

costs for the producer in terms of labour, sometimes inputs (of biological origin). In the absence of incentives to produce differently in the form of financial compensation offered by aid mechanisms, these additional costs have to be offset, via new agri-chains, by new and more remunerative outlets and by a targeting of more quality- and environment-conscious customers. The articulation between agroecological production practices and specific commercial practices is crucial. The transition can be based on new market dynamics with a relocation of productive systems, a proximity between producer and consumer (direct sales and short circuits), and the establishment of new standards and guarantee mechanisms (certification of systems or products) (Chapter 15).

Because it concerns the food system, the agroecological transition marks a break with the socio-technical system resulting from the Green Revolution, characterized by the standardization of products, long supply chains, and the involvement of numerous intermediaries such as processors and large, even global, distributors. Indeed, the processing and marketing systems for products from agroecology are much more diversified. Consumers, producers and processors often weave intertwined, networked, quasi-partnership relationships (Thérond *et al.*, 2017). These new food systems challenge existing ones, coexist with them or hybridize. The concept of the localized agrifood system (LAFS) and its concrete applications – although not covered in this book, but which has been extensively documented in the literature – is a good example of these new systems that will have to be designed, bringing together small businesses and territorializing these systems' different functions (production, processing, marketing).

The topic of marketing was explored in Chapter 15. Based on case studies, the authors note the diversity of marketing experiences and draw lessons about the potential and limitations of these market mechanisms when impacts at significant scales are sought:
– the success of marketing initiatives for products of the agroecological transition depends mainly on the resistance shown by the dominant socio-technical system (standardization of products, length of supply chains, price requirements, lack of information to consumers, etc.); some initiatives manage to influence or help to modify these elements, others stay separate from them;
– the institutionalization of processing, the formalization of quality assurance modalities, and the role of States in supporting the transition are essential elements for stimulating innovation and providing opportunities for farmer organizations and territories searching for new ways of producing and marketing;
– a linkage exists between production practices and methods to derive value from the market; the case studies highlight the observation that strong certification systems (backed by territorialized groups or social movements) are more systematically associated with significant agroecological transitions.

Evaluating and producing new localized knowledge in order to innovate and cope with uncertainty

Production volumes per unit area and economic profitability are often the only metrics used to measure the performance of agricultural production methods. This book's various chapters emphasize the need to change the way agricultural systems are

assessed in order to qualify and measure a set of functions carried out by agriculture and to compare the performance of agroecological systems with that of other systems (Chapter 1, 5, 6, 8, 11, 12 and 16).

The challenge of assessing the sustainability of agricultural systems

There are very many economic, social and environmental dimensions of sustainability, acting in a synergistic or antagonistic manner with each other. Each of the various development actors has his own vision of the relative importance to be accorded to each sustainability indicator. The assessment also depends on the spatial and temporal scales chosen. These few observations reveal the complexity and challenge of assessing farming and processing systems in terms of sustainable development (Chapter 12). Every assessment is conditioned by the norms, values and objectives on which it is based. In this sense, assessing the impact of these systems on sustainability can also be a political act, which must then be based on a process of consultation on objectives to focus on, actors to support, benefits to maximize, and trade-offs to accept. Assessment is therefore not just about measuring phenomena and producing knowledge to be used subsequently to inform decision-making.

The question of assessing the impact of the mode of production on sustainability requires an interdisciplinary approach. In Chapter 12, the authors examine, for example, how to quantify the benefit that would accrue to society from the conservation of a small area of fertile land by a few farmers whose individual incomes and labour productivity would, however, suffer from the adoption of these conservation measures. It remains to be decided what form of monetary or non-monetary compensation this benefit deserves. Similar questions arise for biodiversity, landscape quality, and water resources. Methodological advances in environmental economics and their applications in the forest and carbon sequestration domains can point the way to a multicriteria assessment to accompany the agroecological transition.

Evaluating a set of services and trade-offs between services

Services rendered to society as a whole by agricultural ecosystems can no longer be reduced to the sole production of commercial goods measured by economic value. In addition to the basic services of supply (food, fibre, energy, materials, etc.), agriculture and forests provide a range of services to society: regulation services (water cycle, greenhouse gases, pests and diseases), cultural services, etc. The assessment of these different services – and of their negative impacts, i.e. the disservices that can be generated – calls for a rethinking of the implications of agricultural activities for society. The citizen-consumer is becoming aware of the value of these services and is increasingly willing to pay a premium for quality and territorial products and for those produced ethically or in an ecologically responsible way. Indeed, the private sector and entire agri-chains are structuring themselves around this fast-growing demand. The assessment of these services obviously raises the question of the search for acceptable trade-offs between these services and for arbitrations that can be made through levers for change in agricultural practices, the territorial organization of activities, and

incentives and penalties through public and private policy instruments. These arbitrations themselves depend on the values accorded to these services by territorial actors, markets and public policies (Chapters 5, 8 and 16).

Developing standardized and shared methods of assessment

Proposing new assessment methods and tools – or improving existing ones – that are understandable, robust and widely adoptable remains a priority. Only then can we have common references for the comparative assessment of the performance of production and processing systems (Chapters 1, 5, 6, 7, 8 and 12). For example, life cycle analysis is a standardized method that illustrates this relook at approaches for assessing systems. It is based on an assessment that encompasses all the resources mobilized by a production process. It is well-suited to the environmental assessment of production and processing systems in their overall dimension, without being limited to the local impact of a particular practice. Research is also being conducted to make it a tool for assessing social performance and at a territorial scale (Chapter 6). The research community has developed other methods that are based on mathematical tools (multi-attribute method and constrained optimization method, for example) but which are still little used by development actors (Chapter 12). It must be recognized that methodological advances in the environmental, economic and social assessment of sustainability remain uneven. Even though environmental assessment remains a complex exercise, there already exist a set of methods and tools for qualifying environmental system performance and impacts. But few methods and tools are available to evaluate economic and, in particular, social performance (Chapter 12). For example, quantifications of the notions of equity, distribution of added value, and employability in rural areas remain major challenges.

Combining different scales of assessment of performance

The need to develop the ability to undertake multi-scale assessments of the economic, social and environmental performance of systems was noted in the feedback from several sources involved in the case studies presented in this book. Defining integrated indicators of system performance at different organizational levels is a priority for researchers and development agents; it will allow choices and trade-offs to be made that incorporate the views of as many actors as possible. In this respect, the territorial level clearly stands out as does the conception of new forms of organization that contribute to the sustainable management of resources (Chapters 5 and 7). It is at this level that the use of resources and the trade-offs in their uses are negotiated. Indeed, the territory is defined by a community of life and action that leads to and underpins such decisions (Chapter 16).

Challenges for the agroecological transition

More involvement is necessary at the national and international levels

In addition to the organizational levers (innovation platform and territorial mechanism) and economic levers (actions concerning markets and agri-chains), political levers too

appear to be essential for the implementation of the agroecological transition (Chapters 6, 8, 10, 14, 16 and 17). The widespread application of the agroecological transition depends on the implementation of dedicated national policies and their ability to derive value from new services. The importance of these national policies can be appreciated by recalling the role they played in the implementation of the Green Revolution.

The Green Revolution was promoted after the Second World War and in the early 1960s, in countries of the Global South, in a context of regional famines and risks of global food shortages. Under the auspices of major donors and international agencies, a set of investments, technological packages, credit systems, and mechanisms for institutional and financial support were put in place. These policies were also adopted, with different national trajectories but on similar principles, in countries that are today industrialized or emerging. The effort was indeed more intense in the countries of the Global North and in South and Southeast Asia, in a context of the cold war. The Green Revolution was thus initiated in a world in which States played a decisive role and in which still-nascent world governance benefited from a significant impetus (Figure 18.1).

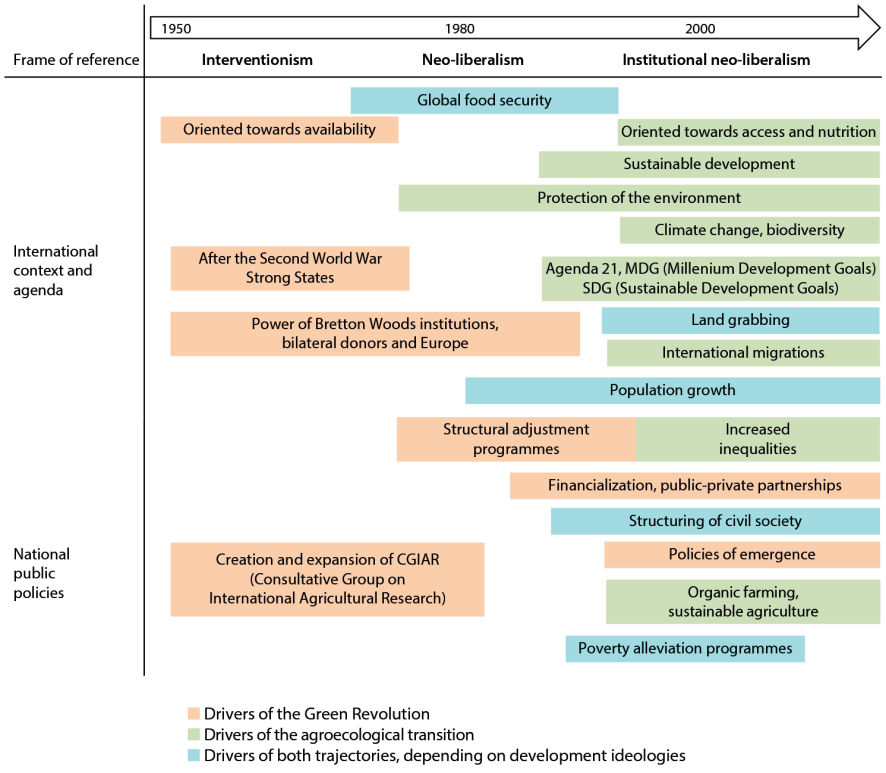

Figure 18.1. The international drivers of the Green Revolution and of agroecology from 1945 to 2018.

In Figure 18.2, we compare the main characteristics of the Green Revolution with those expected from or already known to belong to the agroecological transition. This figure shows the limitations of agroecology according to the proponents of the Green

Revolution, namely its economic risks arising from the inability of its models to produce enough, for the farmers themselves, and even beyond for society as a whole. These risks include the supposedly lower involvement of agri-chains, with potential negative consequences for the agrifood sector of today.

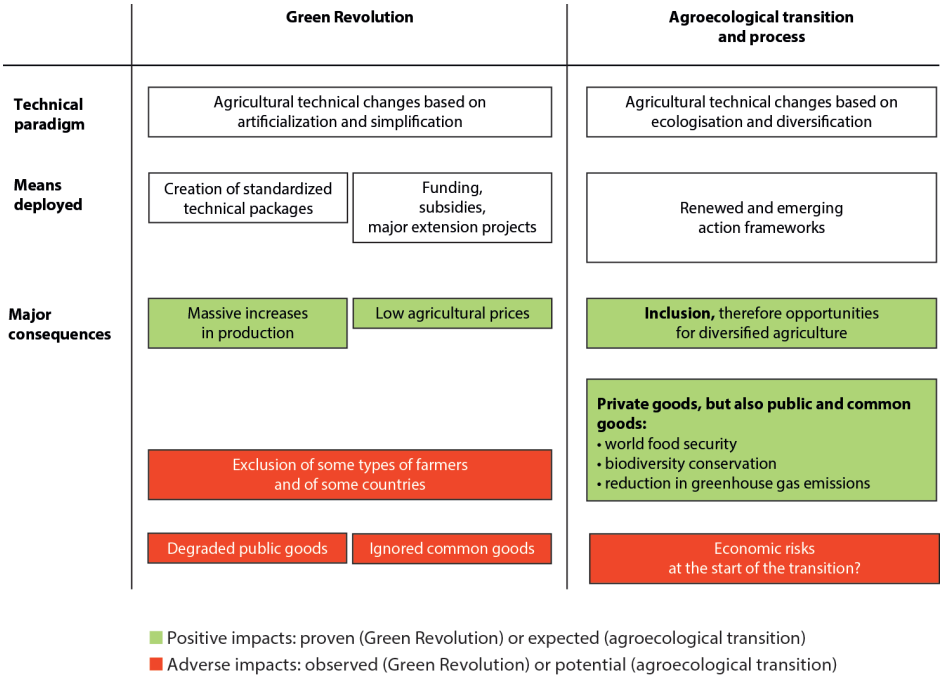

Figure 18.2. Schematic comparison of transitions leading to technical change in agriculture in the context of the Green Revolution and in the context of the agroecological transition.

This comparison, even while the various agricultural models continue to be used simultaneously, raises the question of the international and national political support for the agroecological transition. The Green Revolution attained its objectives because it benefited, at the national and international levels, from significant amounts of direct and indirect funding when it was rolled out (soft loans and investments in infrastructure, national and international research and support services, etc.) and continues to benefit from it even today in the form of a large number of direct and indirect subsidies through market policies. As always, public action is crucial to drive change. This quick comparison shows how national public policies and international agendas played a key role in the success of the Green Revolution. The agroecological transition will also have to receive similar forms and levels of support in order to develop and succeed.

Articulating the different action frameworks of the agroecological transition

In this summary of the book, we have presented the different frameworks for supporting the agroecological transition. Each framework provides a set of functions summarized in Table 18.3. In addition to the mechanisms of action described above,

we also include in this table the civil society initiatives that we consider essential for the development of the agroecological transition and which we describe in greater detail in the following section.

Table 18.3. Functions of the various mechanisms to support the agroecological transition.

Expected function	Mechanisms of action of the agroecological transition					
	Innovation platforms	Territorial mechanisms	Support for market insertion and the development of new agri-chains	National public policies	International agendas	Civil society initiatives
Analysis of the context of production, processing and food systems	+++	++				
Analysis of the context (standards, actors, sharing rules)	+++	+++				
Multi-criteria assessment of system performances	+++	+++	++	+	+	++
Design and experimentation of technical solutions	+++	+		+		+
Design/assessment and experimentation of organizational solutions	++	+++	+			+
Formulation of standards on production methods and product quality	++	++	++	+++		++
Definition of rules and standards	+	++	+	+++	++	++
Resource management at local and regional scales	+++	+++		++		++
Resource management at global scales (essentially worldwide)		+		+++	+++	
Financing the agroecological transition	++	++	++	++	+++	
Contribution to the modification of agri-chains and markets (new service markets, other remunerated intrinsic and extrinsic quality criteria, etc.)	+	+++	+++	++	++	+++
Design and implementation of advocacy strategies for the agroecological transition	++	++			++	++

The number of crosses denotes how much a particular support mechanism (columns) contributes to functions (rows) expected for the implementation of the agroecological transition.

The agroecological transition requires an ambitious agenda and one of the major challenges in undertaking this transition is the ability to link the different frameworks of action, most notably by organizing the flow of information between them. In Figure 18.3, we attempt to depict the relationships between these different action frameworks.

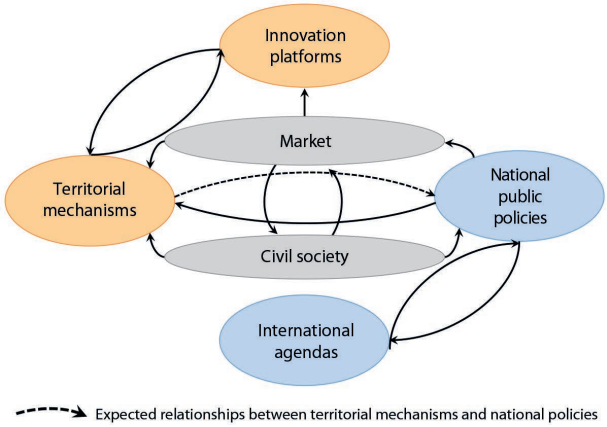

Figure 18.3. The mechanisms of action of the agroecological transition.

Orange ellipses indicate local mechanism, while blue ellipses are mostly mechanisms external to the territories. Grey ellipses indicate mechanism that can be local or external, depending on the context.

In this figure, there are three main groups. This first consists of local frameworks which include innovation platforms and territorial mechanisms, closely tied and sharing actors and locations. The second consists of more external frameworks (such as national public policies, international agendas and major international agreements). And, finally, markets and civil societies constitute a group and have their own dynamics and interact closely with each other.

The agroecological transition can take shape at the local level, irrespective of the links with other scales. This local level can also benefit from the dynamics of urban centres, some of which take charge of the organization of their food systems, or even come together with other like-minded urban centres in some cases to exchange experiences and build up their capacities for action. It seems likely that the agroecological transition has to take place first at the local and regional levels. Beyond these levels, the transition's implementation depends above all on the orientation of national policies, their capacities to accord value to the various services of production systems based on the principles of the agroecological transition, the influence of civil society, and the willingness and ability of markets to pay a premium for new ways of producing.

Building and sharing transition advocacy strategies with producers, policymakers and consumers

An observation reported in this book – shared by a multitude of actors engaged in supporting the agroecological transition – is that even though we have accumulated knowledge and experiences that should make it possible to initiate this transition, it is still not widely recognized or implemented. With very few exceptions, the drivers of transition are not yet sufficiently active, visible, or effective. Even though society and

public authorities are becoming increasingly conscious of the fact that the challenges facing us are urgent and need to be addressed immediately and even though we know that we are compromising our future through inaction, the complexity of international governance, the rigidities of national public funding mechanisms, the inertia of public decision-making at all levels, the low incomes of producers, and the corporate world's desire for short-term profits and quick returns on capital are leading to delays in decision-making and actions. It is clear that this transition, which seems unavoidable, will not be easy: it hurts powerful interests and calls into question our established modes of consumption. Very probably, it is only when the majority of civil society (consumers and citizens) will be convinced of the urgency of the situation and will exert pressure through the market that transformations will start to take place. We must therefore continue to document challenges, share experiences, assess the contribution of the agroecological transition to sustainability and to various services, compare production methods and food systems on the basis of relevant indicators to differentiate between those that contribute to a desirable and entirely possible sustainable development and those that do not, and communicate effectively and widely about it. To design convincing advocacy strategies, we must continue local and territorial agroecological transition experiments and to seek to understand in greater depth the conditions conducive to and consequences of the success of initiatives, especially those that encompass coherent action at different organizational levels and result in a transition on a significant scale.

Furthermore, citizen awareness and activism will also have to rely on unambiguity and important orientations in public action. It will be necessary to build coalitions bringing together the agricultural sector and consumers (especially urban ones) to apply political weight, including internationally, on decision-making in favour of agroecology and to correct the imbalance of power relationships between the proponents of conventional socio-technical models and those of agroecological models. For this reason, the conditions of access to land, investments, technical advice, markets and financing must be called into question and revamped.

Non-governmental organizations and their groupings such as the Working Group on Agroecological Transitions (French abbreviation: GTAE) have played and continue to play a determining role in promoting the agroecological transition at local, regional and international levels through training, research and development activities.

The agroecological transition must also be part of a context in which other transformations are taking place and profoundly changing the world: the energy transition and the irreversible decline of fossil energy sources, the continued depletion of non-renewable resources, and the ongoing deterioration of ecosystems and loss of biodiversity. The ability of the agroecological transition to provide some solutions to the problems posed by these other global changes must be a major component of any advocacy strategy.

Analysing and documenting the factors that can trigger the agroecological transition at a significant scale

Several key points emerge from this book's various chapters on the conditions that have to be satisfied so that local experimental initiatives can contribute to a generalization of agroecology-based practices and food systems.

We avoid here the expression 'scaling up' since it represents a concept that is not suited to agroecology. Indeed, it is based on the assumption that a solution should be tested locally and then replicated more widely. And yet, we have seen that the contexts of the agroecological transition vary from situation to situation every single time, so that replication often proves difficult or impossible to achieve without adaptation. In fact, a multiplicity of actions at different levels of organization, undertaken in a coherent way, is necessary for the transition to take place. While a technical change can be tried out at the scale of a cropping or livestock system, the agroecological transition takes shape only if there is a change in the organization of the farm, organizational changes in the territories and agri-chains, changes in public policies, consumer initiatives, etc.

The value the market ascribes to products is, as we have seen, one of the important factors for achieving the agroecological transition on a significant scale and for it to have any meaningful impact. To this end, it is necessary to build alliances with the private sector, especially companies, global or local, willing to assume some of the risks of this transition. It is a broadening that is proposed here: even though agroecology was born in the production domain, in particular to take its ecological and environmental dimensions into account, its deployment calls the entirety of the food systems – beyond the sole stages of production and processing – into question.

The need to take long timelines in the process of the agroecological transition into account was also emphasized in this book, especially those of learning: results often fall short of promises due to the incompatibility of the 'project' approach with the pace of individual and collective learning (Chapter 14). Any implementation of the agroecological transition at a significant scale must take this aspect into account.

Generating new knowledge and renewing research approaches

Although very significant progress has been made over the past ten years in understanding the biophysical and organizational mechanisms that have to be implemented for an agroecological transition, there is still need to generate knowledge. We note, in particular, the following research activities that have to be undertaken as a priority in order to help develop this transition.

Better explaining of the role of diversity

Different chapters of this book show that there is need for a specific research effort on understanding biodiversity-related biological regulation mechanisms. Examples include the functioning of soils, the management of biodiversity at the combined scales of the plot and the landscape, and the study of the links between biodiversity, climate risk and resilience (Chapter 13).

Proposing new performance indicators

In general, there is a need to better measure the contribution of agricultural and food systems to ecosystem services and to attaining the sustainable development goals. This involves not only the documentation of domains still not well known in farming systems, such as labour productivity and ergonomics, but also, at other temporal scales, the adaptation of systems to climate change and the depletion of water resources in

many regions. It is also necessary to be able to measure the capacity of systems to generate employment, reduce inequalities, and promote social development at the territorial and other spatial scales.

Conducting social science research on supporting innovation for the agroecological transition

Social science research is required to understand and strengthen individual and collective learning processes and mechanisms for coordination between actors to help them innovate (networks, platforms, etc.). It is also important to better characterize and reinforce the capacity of innovation support services, especially as regards innovation's different phases.

Identifying the contribution of agroecological systems to the functioning and sustainability of food systems and territories

As we have seen earlier, the agroecological transition and transition of food systems are closely tied. Moving forward on the path of agroecological transition also means identifying in an unambiguous way the connections that link this transition to the development of new food systems. To this end, it is necessary to:
– better characterize the diversity within food systems and its effect on consumer health;
– study the organization of food systems and their sustainability, in relation to production methods and the effects of different types of public or private intervention on these systems (e.g. procurement by public canteens);
– study material flows at the scale of territories (recycling and reuse of effluents and waste, biomass management, pollution treatment) and usage trade-offs in a circular economy context;
– quantify and measure the contribution to employment (and the quality of this employment) of the different modes of production, processing and distribution.

Understanding and formulating public action adapted to the needs of the agroecological transition

Many of this book's chapters emphasize the crucial importance of public action in expanding the agroecological transition beyond the local level. The key research activities for the development of public action concern, for example:
– at the national level, the multisectoral analysis of existing policy frameworks (environment, agriculture, transport and infrastructure, water and agricultural hydraulics, trade, etc.), their ability to support the transition, and their impacts on territories;
– at the regional or territorial level, the contextual identification of the appropriate modalities of financing the transition (investments, economic and financial instruments, banking and credit systems, etc.);
– the exploration of innovative methods of remuneration, by the State or the markets, for services rendered;
– the co-construction of public action by territorializing national public policies (adaptations, taking constraints and needs into account) in line with principles of inclusion, equity and sustainability.

Taking gender specificity into account

FAO estimates that women produce 60 to 80 percent of the food in most developing countries and are responsible for half of the world's overall food production. They are also often the main actors in processing and marketing. There can therefore be no agroecological transition without taking the role of women into account. This role, although slightly better recognized in recent years, remains poorly documented and has been little covered in this book. It is up to the research community and its partners to fill this lacuna, in an active, committed and scientifically and methodologically sound manner.

The consideration of gender specificities in technical or intangible skills should make it possible to adapt agricultural support and advisory systems in order to make them more equitable. These systems have historically favoured men and their activities, and have thus exacerbated power disparities between the sexes. A gender-based approach could therefore help rebalance decision-making powers between men and women in agricultural households, while improving intra-family cooperation for an improved leveraging of collective skills and leading ultimately to better technical, social and human performance.

By building on the work of Guetat-Bernard (2014), Prévost *et al.* (2014) and Lourme-Ruiz *et al.* (2016), we have identified several areas of work that seem to us to be priorities in order to document and recognize the place of women as important actors in the agroecological transition.

First, it is important not only to characterize the place of women in the processes of production, transformation, marketing, but also the differentiated access to resources and factors of production (land for example), of which they are often deprived. It is a matter of characterizing the distribution of value in terms of the role of women and their jobs and responsibilities.

It is also a question of documenting their specific knowledge and skills in the field of agrobiodiversity, seeds, and the processing of products, especially as concerns food; their roles not only in productive and decision-making processes at the level of the household or the farm engaged in agroecology but also in decision-making processes at local, national and international levels, and in particular their vision of innovation processes; and their specific participation in knowledge networks and in the circulation of technical information within local communities in a context of transition.

Finally, we must examine the risk of women being re-relegated to domestic tasks, which often happens when there is a change in technical systems.

We believe that it is essential for the scientific communities working on gender issues and those working on the biophysical and organizational processes of agroecology to come together to document the current role of women and the one they should ideally play in the agroecological transition.

Rethinking the role of the research community

In addition to the need for producing new knowledge on these themes, there is a need to ensure that the posture of the research community continues to evolve. Indeed, the role of research stemming from the Green Revolution – top-down, normative and prescriptive – is being called into question by the contextualized and multi-actor nature of the agroecological transition. This new transition requires taking a gamble

on local innovation systems and recasting scientific questions and the manner of addressing them in the light of these new relationships with local actors. Research is therefore increasingly required for studying new inter-actor and cross-sectoral collaborative processes, and even for its ability to play a facilitating role by mobilizing the various actors involved in the transition.

Conclusion

Feedback from experiments and experiences presented in this book converges to a few salient points that characterize the state of progress of the agroecological transition and which highlight its achievements as well as its difficulties. To change production methods and food systems in order to make them more sustainable, it is possible to promote a transition to technical alternatives that are based on the concepts of agroecology, in accompaniment with organizational and institutional changes. The usability and relevance of these alternatives depend on a territorial context that is always unique in terms of actors involved and availability of capital and assets (human, social, physical, natural, financial).

This dependence means we have to be very cautious about any ambition we may have for replicating an agroecological transition at a large scale simply through dissemination, duplication or the extrapolation of locally adopted solutions to much larger territories. The agroecological transition is above all the reorganization of a system in its entirety, on the basis of coordinated individual and collective changes as well as on unique or specific territorial resources.

The contextualization of the agroecological transition, however, does not invalidate the need to capitalize basic generic knowledge, which can help find solutions and undertake innovation in other territories. The analysis of the experiences reported in this book highlights the need for generic knowledge and the lines of research that have still to be pursued.

The agroecological transition is a journey, an iterative, participatory and territorial collective exploratory process based on local knowledge bases, and which mobilizes scientific knowledge. On this path, the research community must ally with other key transition actors (training services, agricultural advisory services, technical and financial services for agriculture, the private sector and agri-chains, local and regional public authorities).

Ultimately, the agroecological transition cannot be fully attained without an awareness on the part of consumers and citizens and without the rise in influence of supra-local driving forces. National and international actors must become involved and provide a political impetus and guidance, and make explicit choices which reflect the very conception they have of societies and of the planet's future.

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